

Anomalous Dynamic Roughening of Cu Surfaces During Oxidation

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Motivation

Surface roughening is a widespread phenomenon that occurs under far-from-equilibrium conditions:

- thin film growth: deposition
- Surface reaction : oxidation

Objective:

Apply dynamic scaling theory to understanding the evolution of oxide surface morphology --- insight into the oxidation mechanism

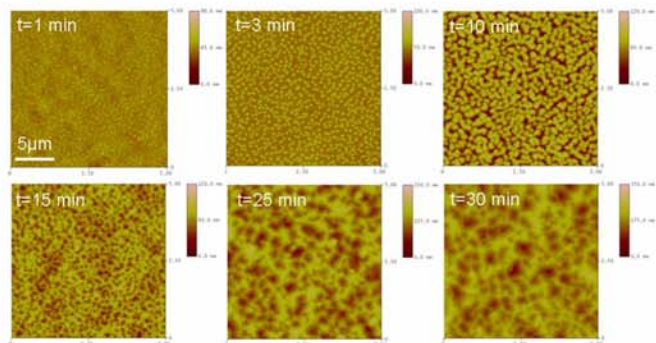
Experimental approach

1. Annealed at 700°C in Ar-2% H_2 for 2 hours: to remove native oxide and improve the surface quality
2. Oxidized at 250°C in $pO_2=5 \times 10^{-2}$ Torr as a function of time
3. Characterization of surface morphology at RT using atomic force microscopy (AFM)

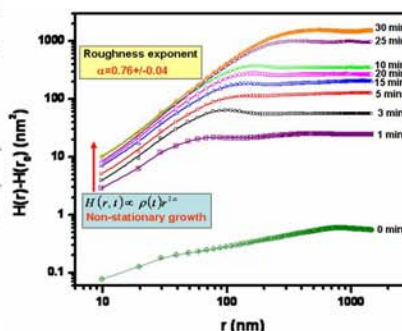


Accomplishments

Oxidation of (001)Cu as a function of time
 $T=250^\circ\text{C}$, $pO_2=5 \times 10^{-2}$ Torr

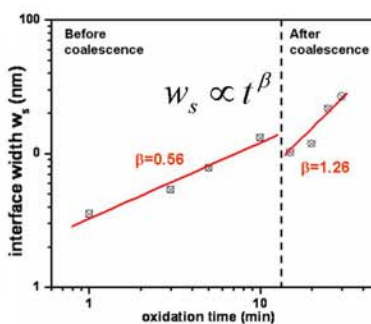
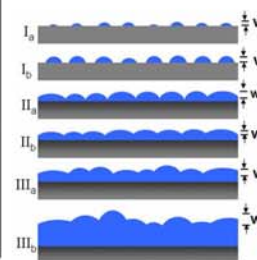
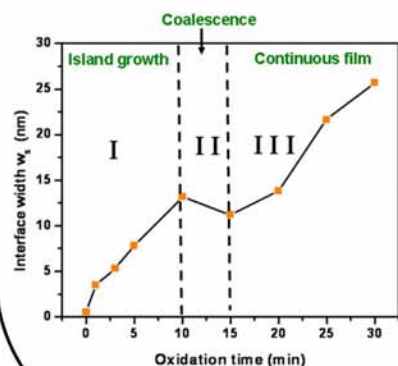


Height-height correlation function obtained from the AFM images



Findings:

- Anomalous dynamic roughening: time dependence of the surface roughening
- Coalescence of the oxide islands leads to a change of dynamic exponent β
- Oxygen surface diffusion controls surface dynamics before island coalescence
- Lattice diffusion of Cu* across the oxide layer does not account for the surface dynamics after the island coalescence



Future directions

Dynamic scaling roughening approach to gas-solid interface:

- Oxide reduction
- Quantitative connection between surface reactivity and surface roughness

Solid-liquid interfaces: chemically tailed AFM tips

- Passivation/corrosion in aqueous conditions
- dissolution behaviors of metals